

1

Image Pickup Apparatus

BACKGROUND OF THE INVENTION

Field of the Invention

5

The present invention relates to an image pickup apparatus such as a video camera.

Related Background Art

a
a

10

In recent years, video cameras have ~~remarkably~~ ^{remarkably} become popular since they have compact, lightweight structures, variable magnifications, and multifunctions.

a

15

In the above-mentioned video camera, most of functions associated with an image pickup operation are automated. Therefore, an unsuccessful image pickup operation caused by the functions of the video camera itself rarely occurs.

a

a

20

The video camera is most frequently used in a hand ^{held} ~~holding~~ state. In this state, the frame may be considered to be always vibrated. In recent years, degradation of image quality caused by the frame vibration, and an uncomfortable situation such as "video sickness" are discussed as problems.

25

As a means for eliminating the above-mentioned frame vibration, an image stabilization device utilizing a gyro mechanism is conventionally known.

In this device, a lens barrel system is movably supported by a gyro mechanism to obtain a stable image.

- 1 However, this device makes the camera main body bulky,
and also causes an increase in weight.

In recent years, an image pickup apparatus, which
comprises an image vibration correction means

- 5 comprising optical axis decentering means such as a
variable angle prism for decentering an optical axis of
an image pickup optical system according to a vibration
of a camera ^{and thereby locating} ~~to locate~~ an optical image on a
predetermined focal plane of an image pickup element,
10 has been developed.

- The variable angle prism has the following
structure. That is, a liquid having a given refractive
index is sealed in an accordion-like chamber having a
bellows clamped between two transparent plates. The
15 transparent plate on the object side is tilted by a
driving mechanism comprising a magnetic circuit,
thereby decentering a photographing optical axis.

- In the above-mentioned apparatus, since the
optical axis is decentered by the variable angle prism,
20 a lens barrel system need not be moved, and increases
in ^{the} size and weight of the camera main body can be
minimized. Thus, a good image can be obtained by
effectively preventing an image vibration.

- In the above-mentioned apparatus, since an image
25 vibration correction is performed by tilting the
transparent plate of the variable angle prism by the
driving mechanism comprising the magnetic circuit,

1 power consumption is increased as compared to a normal
photographing mode. Thus, a demand has arisen for
efficient battery saving means.

In addition, the apparatus using the variable
5 angle prism suffers from the following problem.

In the image pickup apparatus comprising the image
vibration correction means, e.g., the optical axis
decentering means such as the variable angle prism,
when the image vibration correction mode is disabled
10 during an image recording operation, a tilting state by
the driving mechanism for driving the transparent plate
is released, and a centering operation occurs. That
is, the two transparent plates become parallel to each
other due to liquidity of the liquid sealed between
15 them.

For this reason, discontinuous finder images are
formed, and a user may feel uneasy.

SUMMARY OF THE INVENTION

The present invention has been made to solve the
20 conventional problems, and has as its first object to
provide an image pickup apparatus which can effectively
perform an image vibration correction, and can also
effectively perform an efficient battery saving
operation.

25 In order to achieve this object, according to a
preferred aspect of the present invention, there is
disclosed an image pickup apparatus comprising image

1 pickup means for converting an optical image on a focal
plane into an electrical image signal, and outputting
the electrical image signal, vibration detection means
for detecting a vibration amount of an image pickup
5 apparatus main body, optical axis decentering means for
decentering an optical axis so as to cause the optical
image to coincide with a predetermined position on the
focal plane of the image pickup means, driving control
means for controlling a decentering amount of the
10 optical axis decentering means on the basis of a
detection output from the vibration detection means,
and control means for, when the image pickup means
outputs the electrical image signal, controlling to
permit a driving operation of the optical axis
15 decentering means by the driving control means.

According to another preferred aspect of the
present invention, there is disclosed an image pickup
apparatus comprising image pickup means for converting
an optical image on a focal plane into an electrical
20 image signal, recording/reproduction means for
recording the electrical image signal from the image
pickup means, and reproducing the recorded signal,
vibration detection means for detecting a vibration
amount of an image pickup apparatus main body, optical
25 axis decentering means for decentering an optical axis
so as to cause the optical image to coincide with a
predetermined position on the focal plane of the image

1 pickup means, driving control means for controlling a
decentering amount of the optical axis decentering
means on the basis of a detection output from the
vibration detection means, and control means for, when
5 the recording/reproduction means reproduces the
recorded signal, stopping operations of the optical
axis decentering means and the driving control means.

Thus, according to the present invention, when the
image pickup means outputs the electrical image signal,
10 control is made to permit a driving operation of the
optical axis decentering means by the driving control
means. When the recording/reproduction means
reproduces the recorded signal, the operations of the
optical axis decentering means and the driving control
15 means are stopped. Thus, an image vibration correction
can be effectively performed, and an efficient battery
saving operation can also be effectively attained.

It is the second object of the present invention
to provide an image pickup apparatus which can
20 effectively perform an image vibration correction, and
an efficient battery saving operation since it controls
to permit a driving operation of the optical axis
decentering means by the driving control means when the
image pickup means outputs an electrical image signal,
25 and stops operations of the optical axis decentering
means and the driving control means when the

1 recording/reproduction means reproduces a recorded
signal.

It is the third object of the present invention to
solve the conventional problems, and to provide an
5 image pickup apparatus which can effectively perform an
image vibration correction, and can effectively prevent
discontinuous images even when an image vibration
correction mode is disabled during an image recording
operation ~~performed while the image vibration~~
10 ~~correction mode is enabled.~~

It is the fourth object of the present invention
to provide an image pickup apparatus which can
effectively perform an image vibration correction since
it controls to hold an optical axis decentering
15 position of optical axis decentering means when an
optical axis decentering driving operation by the
optical axis decentering means is stopped during an
operation of a recording means, and can effectively
prevent discontinuous images even when an image
20 vibration correction mode is disabled during an image
recording operation ~~performed while the image vibration~~
25 ~~correction mode is enabled.~~

It is the fifth object of the present invention to
provide an image pickup apparatus which can effectively
25 perform an image vibration correction, and can
effectively prevent formation of discontinuous monitor
images as finder images even when an image vibration

1 correction mode is disabled during an image recording
operation performed while the image vibration
correction mode is enabled.

5 In order to achieve the above objects, according
to still another preferred aspect of the present
invention, there is disclosed an image pickup apparatus
comprising image pickup means for converting an optical
image on a focal plane into an electrical image signal,
10 recording means for at least recording the electrical
image signal from the image pickup means, vibration
detection means for detecting a vibration amount of an
image pickup apparatus main body, optical axis
decentering means for decentering an optical axis so as
to cause the optical image to coincide with a
15 predetermined position on the focal plane of the image
pickup means, driving control means for controlling a
decentering amount of the optical axis decentering
means on the basis of a detection output from the
vibration detection means, and control means for, when
20 an optical axis decentering driving operation by the
optical axis decentering means is stopped during an
operation of the recording means, controlling to hold
an optical axis decentering position of the optical
axis decentering means.

25 Other objects and features of the present
invention will become apparent from the following

1 description taken in conjunction with the accompanying
drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing an arrangement
5 of an image pickup apparatus according to the first
embodiment of the present invention;

Fig. 2 is a block diagram for explaining in detail
a variable angle prism, a vibration detecting sensor,
and a VAP driving circuit shown in Fig. 1;

10 Fig. 3 is a flow chart for explaining an operation
of a control circuit shown in Fig. 1; and

Figs. 4 and 5 are flow charts for explaining an
operation of a control circuit according to the second
embodiment of the present invention.

15 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a block diagram for explaining an image
pickup apparatus according to an embodiment of the
present invention.

In Fig. 1, the image pickup apparatus includes a
20 VAP (Variable Angle Prism) 1 serving as an optical axis
decentering means, and an image pickup optical system 2
including an image pickup lens 2a including a focusing
lens, and an aperture stop 2b. The image pickup lens
2a is driven by a focus driving circuit 3, and the
25 aperture stop 2b is driven by an iris driving circuit
4a and an iris control circuit 4b so as to control an

1 incident light amount of the image pickup optical
system.

5 The apparatus also includes a CCD 5 as an image
pickup element for photoelectrically converting an
object image formed on a focal plane by the image
pickup optical system 2 into an image pickup signal,
and a camera process circuit 6 for executing
predetermined processing, e.g., gamma correction,
blanking processing, addition of a synchronization
10 signal, and the like, of a video signal which is output
from the CCD 5 and is amplified by a preamplifier (not
shown), so as to convert the video signal into a
standard television signal, and outputting the standard
television signal from a video output terminal. The
15 television signal output from the camera process
circuit 6 is output to a video recorder section (not
shown), and is also supplied to a monitor 7 such as an
electronic viewfinder.

20 Furthermore, the apparatus includes an unfocused
image width detecting circuit 8 for detecting an
unfocused image width (width of an edge portion of an
object image) of an object image from the video signal
output from the CCD 5. The circuit 8 performs focus
detection by utilizing a nature that an unfocused image
25 width of an object is decreased as a focusing state
approaches an in-focus state.

1 Moreover, the apparatus includes a control circuit
9 comprising, e.g., a microcomputer for controlling the
entire system. The control circuit 9 comprises an I/O
port, an A/D converter, a ROM, and a RAM. The control
5 circuit 9 fetches unfocused image width data output
from the unfocused image width detecting circuit 8, and
peak value data of high-frequency components from a
band-pass filter (not shown), and outputs a
predetermined driving control signal to the focus
10 driving circuit 3 to drive the image pickup lens 2a so
that an unfocused image width in one field period of a
video signal is minimized, and a peak value of
high-frequency components is maximized. The control
circuit 9 receives a detection signal from a vibration
15 detecting sensor 10 for detecting a vibration amount of
a video camera main body as the image pickup apparatus,
and outputs a correction signal for correcting an
optical axis in accordance with the vibration amount
given by the detection signal, and an operation mode of
20 the video camera main body to a VAP driving circuit 11.
The VAP driving circuit 11 tilts the VAP 1 to decenter
the optical axis, so that an optical image from the
image pickup optical system 2 can be formed on a
predetermined position of the focal plane of the CCD 5.
25 The VAP 1, the vibrating detecting sensor 10, and
the VAP driving circuit 11 will be described in more
detail below with reference to Fig. 2.

1 The vibration detecting sensor 10 has a structure
as shown in Fig. 2. More specifically, a cylindrical
case 12 is filled with a liquid 13 having a
predetermined refractive index, and a float 14 which is
5 rotatable about a predetermined rotational axis is
arranged in the liquid 13. In a vibration free state,
the float 14 is held at a predetermined position by a
closed magnetic circuit constituted by a permanent
magnet 15 arranged to surround the case 12. When the
10 video camera main body is vibrated, and the float 14 is
rotated relative to the case 12, signal light from a
light-emitting element 16 is reflected by the surface
of the float 14, and is incident on a light-receiving
element 17 used for position detection. Therefore, the
15 light incident position onto the light-receiving
element 17 is changed depending on the position of the
float 14, and an output signal is changed. The output
signal from the light-receiving element 17 is output to
the control circuit 9 via a position detecting circuit
20 18.

On the other hand, the VAP 1 has the following
structure. That is, a liquid 23 having a predetermined
refractive index is sealed in an accordion-like chamber
22 having a bellows clamped between two transparent
25 plates 21a and 21b. The VAP 1 is arranged on the front
surface side of the image pickup optical system 2 and
the CCD 5. In accordance with an output from the

1 position detecting circuit 18 on the side of the
vibration detecting sensor 10, a magnetic circuit 24 is
driven by the VAP driving circuit 11 controlled by the
control circuit 9, and the transparent plate 21a on the
5 object side of the VAP 1 is tilted. The tilting amount
of the transparent plate 21a is detected by detectors
25 and 26, and output signals from these detectors are
output to the control circuit 9 via a position
detecting circuit 27. The control circuit 9 controls
10 the VAP driving circuit 11 to drive the magnetic
circuit 24, thereby tilting the transparent plate 21a
of the VAP 1, so that a difference between the output
from the position detecting circuit 18 on the side of
the vibration detecting sensor 10, and the output from
15 the position detecting circuit 27 on the side of the
VAP 1 becomes "0".

The operation of the control circuit 9 described
above as the characteristic feature of the image pickup
apparatus of the present invention will be described
20 below with reference to the flow chart shown in Fig. 3.

It is checked if the video camera is set in a
vibration prevention mode (step 1). If it is
determined that the vibration prevention mode is set,
it is then checked if the video camera is set in a
25 reproduction mode (step 2). If it is determined that
the reproduction mode is not set, it is checked if an
image based on an image pickup signal from the CCD 5 is

1 output to the monitor 7 (e.g., in an REC pause or REC
state) (step 3). If it is determined that the image is
output to the monitor 7, the vibration prevention
function is operated (step 4). More specifically, when
5 a picked-up image can be output to the monitor 7, the
vibration prevention function is enabled even when no
image recording operation is performed.

If it is determined that no image based on an
image pickup signal from the CCD 5 is output to the
10 monitor 7, or if it is determined in step 1 that the
vibration prevention mode is not set, and if it is
determined in step 2 that the reproduction mode is set,
the vibration prevention function is turned off (step
5).

15 Therefore, in this embodiment, when an image based
on an image pickup signal from the CCD 5 is output to
the monitor 7, the control circuit 9 controls to enable
the driving operation of the VAP 1 via the VAP driving
circuit 11. When the recorder (not shown) outputs a
20 signal representing the reproduction mode to the
control circuit 9, the control circuit 9 controls to
stop the operations of the VAP 1 and the VAP driving
circuit 11. As a result, an image vibration correction
can be effectively performed, and an efficient battery
25 saving operation can be effectively attained.

The above embodiment exemplifies a so-called TV-AF
system (auto focus system using a television signal)

1 wherein focus detection is performed by utilizing the
nature that an unfocused image width of an object is
decreased as a focusing state approaches an in-focus
state. However, this embodiment may be applied to an
5 active AF system comprising a light-emitting element,
and a light-receiving element.

In the above embodiment, an image vibration
correction mechanism is integrally arranged in the
video camera as the image pickup apparatus. However,
10 the VAP, the vibration detecting sensor, the VAP
driving circuit, and the control circuit may be
separately arranged as an adapter detachable from the
video camera main body. Furthermore, the control
circuit may be used commonly by the video camera main
15 body.

In the image pickup apparatus of the present
invention, as described above, when an electrical image
signal is output from an image pickup means, control is
made to permit a driving operation of an optical axis
20 decentering means by a driving control means. When a
recording/reproduction means reproduces a recorded
signal, the operations of the optical axis decentering
means and the driving control means are stopped.
Therefore, an image vibration correction can be
25 effectively performed, and an efficient battery saving
operation can be effectively attained.

1 The second embodiment of the present invention
will be described below.

 This embodiment discloses an image pickup
apparatus which can prevent discontinuous and poor
5 images from being output as finder images when an image
vibration correction device is mounted on, e.g., a
video camera, and an operation mode of the camera is
changed.

 This embodiment will be described below. The
10 circuit arrangement of this embodiment, and a VAP, a
vibration detecting sensor, and a VAP driving circuit
as a vibration correction means are the same as those
in the embodiment shown in Figs. 1 and 2, and a
difference is only a control program of a control
15 circuit 9 for controlling the overall apparatus.

 The operation of the control circuit 9 as the
characteristic feature of the image pickup apparatus of
the present invention will be described below with
reference to the flow charts shown in Figs. 4 and 5.

20 The VAP as the optical axis decentering means used
in the video camera as the image pickup apparatus of
the present invention can be used in a full auto mode
of the video camera, and in a manual mode capable of
turning on/off the vibration prevention function
25 according to a user's will.

 As shown in Fig. 4, when the full auto mode of the
video camera is set, it is checked if the video camera

1 is set in an REC pause state (step 11). If it is
determined that the REC pause state is set, it is
checked if an output signal from the vibration
detecting sensor 10 exceeds a predetermined value (step
5 12). If it is determined that the output signal
exceeds the predetermined value, the VAP 1 is operated
(step 13). It is then checked if the camera is set in
an REC state (step 14). If it is determined that the
REC state is set, an image recording state with the ON
10 vibration prevention function in which the VAP 1 is
operated is set. However, if it is determined that the
REC state is not set, it is checked if the REC pause
state is set (step 15). If it is determined that the
REC pause state is set, the flow returns to step 2. If
15 it is determined that the REC pause state is not set, a
centering operation is performed, i.e., the tilting
position of the transparent plate 21a of the VAP 1
which decenters the optical axis on the basis of a
predetermined time constant is gradually returned to a
20 centering position where the transparent plates 21a and
21b are parallel to each other (step 16). Upon
completion of the centering operation, the vibration
prevention function is turned off (step 17).

If it is determined in step 2 that the output
25 signal from the vibration detecting sensor 10 is below
the predetermined value, the tilting position of the
VAP 1 is temporarily held (step 18). It is then

1 checked if the tilting position of the transparent
plate 21a of the VAP 1 is offset from the center by a
predetermined value or more (step 19). If it is
determined that the tilting position is offset from the
5 center, a centering operation is performed, i.e., the
tilting position of the transparent plate 21a of the
VAP 1 which decenters the optical axis is gradually
returned to a centering position where the transparent
plates 21a and 21b are parallel to each other (step
10 20). Upon completion of the centering operation, the
flow returns to step 1.

Therefore, when the video camera is set in the
full auto mode, if the video camera main body is
vibrated by a predetermined value or more by, e.g.,
15 camera shake in the REC pause state wherein an optical
image from the image pickup optical system is output to
the monitor 7 as the viewfinder, the vibration
prevention function is automatically operated. In a
vibration prevention function unnecessary state, e.g.,
20 when a vibration by camera shake is stopped, the
tilting position of the transparent plate 21a of the
VAP 1 is temporarily held, and the centering operation
is gradually performed. In this manner, when the
vibration prevention function is switched between ON
25 and OFF states, an image from the monitor 7 as the
viewfinder does not give an uneasy feeling to a user
since the centering operation of the VAP 1 is gradually

1 performed without immediately changing the optical
axis.

The vibration prevention function in the manual
mode will be described below with reference to the flow
5 chart shown in Fig. 5.

As shown in Fig. 5, it is checked if the vibration
prevention function (VAP mode) is selected (step 21).
If it is determined that the VAP mode is selected, it
is then checked if the camera is set in the REC pause
10 state (step 22). If it is determined that the REC
pause state is set, the VAP mode is enabled (step 23).
If it is checked if the VAP mode is turned off (step
24). It is determined that the VAP mode is OFF, it is
checked if the REC state is set (step 25). If it is
15 determined that the REC state is set, the tilting
position of the transparent plate 21a of the VAP 1 is
temporarily held by the driving operation of the
magnetic circuit 24 (step 26). Thereafter, it is
checked if the REC pause state is set (step 27). If
20 the REC pause state is released, it is checked if the
tilting position of the transparent plate 21a of the
VAP 1 is offset from the center by a predetermined
value or more (step 28). If it is determined that the
tilting position is offset from the center, a centering
25 operation is performed, i.e., the tilting position of
the transparent plate 21a of the VAP 1 which decenters
the optical axis on the basis of the predetermined time

1 constant is gradually returned to a centering position
where the transparent plates 21a and 21b are parallel
to each other (step 29).

Therefore, in the vibration prevention function in
5 the manual mode, even when the vibration prevention
function is switched between ON and OFF states, an
image from the monitor 7 as the viewfinder does not
give an uneasy feeling to a user since the centering
operation of the VAP 1 is gradually performed without
10 immediately changing the optical axis.

In this manner, in the above embodiment, an image
vibration by camera shake can be effectively corrected,
and even when an image vibration correction function as
the vibration prevention function is switched between
15 ON and OFF states, an image on the monitor as the
finder can be effectively prevented from being
discontinuously formed.

The above embodiment exemplifies a so-called TV-AF
system (auto focus system using a television signal)
20 wherein focus detection is performed by utilizing the
nature that an unfocused image width of an object is
decreased as a focusing state approaches an in-focus
state. However, this embodiment may be applied to an
active AF system comprising a light-emitting element,
25 and a light-receiving element.

In the above embodiment, an image vibration
correction mechanism is integrally arranged in the

1 video camera as the image pickup apparatus. However,
the VAP, the vibration detecting sensor, the VAP
driving circuit, and the control circuit may be
separately arranged as an adapter detachable from the
5 video camera main body. Furthermore, the control
circuit may be used commonly by the video camera main
body.

As described above, according to the image pickup
apparatus of the present invention, an image vibration
10 correction can be effectively performed, and even when
an image vibration correction mode is disabled during
an image recording operation performed while the image
vibration correction mode is enabled, monitor images as
finder images can be effectively prevented from being
15 discontinued.

20

25